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COMPOSTING AND GRINDING

Report of a Subcommittee of the Committee on Refuse Collection and Disposal of the Sanitary Engineering Division

SANITARY ENGINEERING DIVISION

{Discussion open until March 1, 1955}

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THIS PAPER

--represents an effort by the Society to deliver technical data direct from the author to the reader with the greatest possible speed. To this end, it has had none of the usual editing required in more formal publication procedures.

Readers are invited to submit discussion applying to current papers. For this paper the final date on which a discussion should reach the Manager of Technical Publications appears on the front cover.

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COMPOSTING AND GRINDING

Report of a Subcommittee of the
Committee on Refuse Collection and Disposal of
the Sanitary Engineering Division

This report on Composting and Grinding is one of a series produced by Subcommittees of the Sanitary Engineering Division's Committee on Refuse Collection and Disposal. Other subcommittees have reported on Garbage Reduction; Dumping and Land Fill; Hog Feeding; Incineration; Refuse Collection; and State Activities and Fiscal Aspects. These reports are being published as separates as they become available. While not consecutively issued or numbered, the reports will form a series representing the final report of the Committee on Refuse Collection and Disposal.

The committee consisted of:

Henry W. Taylor, Chairman

Norman W. Nester	Charles L. Senn
Newell L. Nussbaumer	V. M. Ehlers
Sol Pincus	Charles L. McGauhey

Members of the Subcommittee concerned are listed at the end of this and the other Subcommittee reports.

FOREWORD

In 1901, M. N. Baker made the following and now classic statements

"In no branch of municipal service has so little progress been made in the United States as in the disposal of garbage. Why do such conditions exist? First, because the sanitary collection and disposal is appreciated neither by the general public nor the city officials; second, because it is seldom recognized that the problems incident to final disposal are largely engineering in character and therefore should be entrusted to engineers."

Mr. Baker's statement could be enlarged in scope by substituting "refuse" for "garbage" and adding emphasis to the need for engineering technique and administration in collection as well as in disposal methods.

Activities of this Committee on Refuse Collection and Disposal since its inception may be briefly summarized as follows:

In 1935 the Sanitary Engineering Division appointed a "Committee on Technical Aspects of Refuse Disposal" and this Committee functioned until January, 1942, during which period four reports were submitted and abstracted in Civil Engineering. The final report of this Committee stated that:

> "due to the unusual activity of members of the Committee and on account of the lack of general interest in the subject under consideration at this time, together with a feeling on the part of the Committee Members that the subject is not particularly well adapted to Committee action, it is recommended that this Committee be discontinued."

The "unusual activity" of Members of the Committee still exists. Any lack of general interest in this subject has been replaced by the pressing necessity of solving a municipal problem which places increasing demands on public officials and engineers. A new Committee was appointed in 1947 and a progress report was submitted by the Chairman, Rolph Eliassen. This progress report outlined many of the facets of this subject and the need for application of engineering technique and administration.

At the 1949 meeting of this Society, a report was submitted by the Committee on "Advancement of Sanitary Engineering," which recommended the collaboration of the personnel from other technical organizations in the activities of Committees working on projects of broad scope. The recommendation met with quick approval and the present Committee has attempted to put these recommendations into tangible form by introducing Subcommittees who operate as task groups under the leadership of the personnel of the base Committee.

A report by the Committee in January 1950 confined itself to the organization of the Committee and Subcommittees with a prospectus of objectives. A Progress Report was submitted in October 1952 and included the efforts of seven Subcommittees.

This report for 1953 may be considered as the final report of the Committee with the objectives originally stated by this Committee. The increased activity in research, in design and operation are leading to an extensive program of literature emanating from individuals, colleges, institutions and commissions and any attempt by this Committee to include all this data would be futile and a subsequent report would be largely a bibliography of this literature. In other words, present activities have extended beyond the scope of the Committee and involve a volume of current literature from various sources which are

available from their original source.

This report is actually individual reports of the seven task groups acting as Subcommittees. The Chairman has considered that each group contains acknowledged experts within the scope allotted to it and has not, in general, modified or condensed the reports as submitted by these separate Subcommittees. He has also considered that it would be impracticable for the base committee as a whole to attempt to pass on or modify the work of the individual groups since the scope of these groups includes such a varied field.

The Chairman has reduced the personnel of various Subcommittees, as stated in this report, to those who have been able to devote time and submit data to their various Subcommittee Chairman. The Chairman wishes to express his appreciation of the cooperation of the Committee and Subcommittee members.

HENRY W. TAYLOR, Chairman

ASCE Committee on
Refuse Collection and Disposal

COMPOSTING

INTRODUCTION

Composting has long been practiced in Europe and other parts of the world as a waste recovery process. Poor natural resources and intensive farming operations have led to a search in these areas for fertilizers produced by composting readily available organic wastes, such as sewage sludge and municipal refuse, to take the place of the more expensive inorganic chemical fertilizers.

In the United States soil conservation and rebuilding through the use of organic fertilizers has not assumed a great role in agriculture because organic fertilizers, such as those produced by composting, must compete with cheap inorganic fertilizers. Therefore, while composting as a means of waste recovery has been economically feasible in other areas of the world, there is little evidence that it is a profitable operation from the point of view of waste recovery in the U. S.[2]

The chief hope for composting in this country lies in the field of waste disposal.[3] Composting should be considered as one of the several methods of refuse disposal available to the engineer in solving any particular waste disposal problem. Where land fill operations must cease for lack of land within economical hauling distance or where incineration or dumping are objectionable (because of smog or other health hazards) composting should be considered by responsible engineers and public officials as a method of waste disposal.

Right now, more is known about the bio-chemical processes which enter into composting than about operating costs under commercial operation. The final adoption of composting by American refuse disposal practice depends upon solving a materials handling problem. Engineering judgment as well as ingenuity will have to play a part in mechanizing the basic steps involved in the composting process and speeding up the process so that is will be fast and economical.

Basic Steps in Composting

The failures of the anaerobic composting processes when tried in this country[1] and success of some of the aerobic processes started in the U.S. make it evident that the development of composting here will depend upon aerobic decomposition of organic refuse. Aerobic decomposition offers nuisance free decomposition which is more rapid than the older anaerobic methods.

The fundamental steps for aerobic composting include (a) removal of non-compostables, (b) grinding, (c) moving and placing for composting, (d) turning or aerating, (e) regrinding and bagging or storing in bulk for sale.

Removal of non-compostables must be undertaken to permit efficient grinding. Tin cans, and glass are the most objectionable. If separate collections could be enforced the segregation of compostables would be a simple matter. From a practical viewpoint, composting operations must be based upon the assumption of mixed refuse arriving at the compost plant. To

mechanize the removal procedure a conveyor belt with magnetic sorter for ferrous metals should be provided. Hand picking of non-combustibles from the conveyor belt will remove glass and other objectionable items. Hand picking of rags for salvage may be profitable and paper can also be salvaged if desired. Blower arrangements have been used to remove excess paper from the conveyor belt for salvage purposes or to reduce the C/N ratio. Tests of the amount of compostables remaining after initial segregation from a study of a number of California cities[2] indicates that approximately 66% of municipal refuse can be composted.

Studies[2] show that the C/N ratio controls the rate of decomposition of refuse. The higher the C/N ratio the greater the length of time required for composting. For rapid composting the C/N ratio should be between 30-35. C/N ratios above 50 slow the process and lower the quality of the finished compost. Too much paper in the refuse will raise the C/N ratio above the desirable limits.

The second basic step necessary for good composting is grinding of the raw refuse. The development of efficient grinders which can handle the abrasive American refuse and render it fit for composting is one of the problems which must be solved to make this method of waste disposal economical and practical. Grinding is important because it makes the raw material susceptible to bacterial decomposition.

Care must be taken during the grinding operations to prevent the raw material from becoming too soggy to compost. For rapid composting of municipal refuse a moisture content between 40 and 65% has been found to be most desirable.[2] If moisture content is too high additives such as straw, paper, soil or sawdust can be added during the grinding operations.

In the U.S. various experimenters in the field of composting[1] have argued that special strains of organisms, which they alone can produce must be added to get the process going. From the studies at the University of California[2] it seems that the micro-organisms necessary to get the composting process started are already present in the raw material and therefore innoculation by special cultures is entirely superfluous. Even seeding of municipal refuse by using horse manure in amounts up to 30% of total weight and the use of tailings (previously composted material) has no measurable effect on the composting process according to these investigators.

After the grinding operation, the raw material must be stacked or piled for aerobic decomposition. Various cells or digestors have been developed[1] in which decomposition may proceed; usually with the addition of air to keep the process aerobic. To keep costs down, open air composting can be practiced in many parts of the United States where the amount of rainfall is low and ground temperatures are high.

For open air composting in dry, warm climates, the ground refuse may be composted in windrows. Maximum height of pile should not exceed 5-6 feet to prevent compaction and minimum height should be 4 feet to maintain good insulation properties. In tests of typical open air compost piles in California [2] [8] the temperature was found to rise to 50° C within one day and to more than 60° C in two or three days. At these temperatures pathogenic disease germs are killed and fly larvae are inhibited.

In wet areas, decomposition in piles similar to those discussed above for open air composting can be carried out under a roof. The design of a shed to house indoor composting operations can be simple to keep costs down.

Turning of the piled compost must be accomplished in order to secure aerobic decomposition. Turning of the outer edges of the pile into the center

of the pile should be done on about the third day after grinding and repeated at intervals thereafter, depending on the moisture content. The higher the moisture content the more frequent the turnings must be to prevent anaerobic conditions. Tests indicate[2] that for open air composting piles must be turned every day for moisture contents greater than 70% ; every 2 days for moisture content between 60-70% and every 3 days when moisture content is 40-60%. If moisture content is less than 40% water should be added during turning operations. For open air composting, no turning should be done during rainfall to prevent waterlogging.

To increase nitrogen in final product municipal refuse can be composted with raw or digested sewage sludge added after grinding and stacking before the decomposition process is undergone. The amount of sludge that can be added depends upon the initial moisture content of the sludge and refuse for composting.

Compost piles must be judged by temperature, color, physical appearances and laboratory test to determine if the desired aerobic decomposition is proceeding. Finished compost usually has a dark brown color-earthy odor and a C/N ratio of 20 or less. For open air composting with favorable C/N ratios, the decomposition process is completed in 12 days. Refuse having initial C/N ratios which are high may take as much as 21 days to go through the complete decomposition process.

If composting is done by piling raw material in small stacks in the open or in a closed shed, in turning the mass periodically to aerate the piles, a materials handling problem arises. Bulldozers, trucks and special turning equipment must be developed to do the work efficiently and economically. Each community's problems are individual because of the many variables possible in composting operations and a great deal of ingenuity can be practiced.

After the decomposition has been completed, regrinding and drying of the finished compost can be undertaken to improve its marketability. At the present time much of the finished compost is sold in small packages at a high cost. In order for composting to become economically feasible, production must increase and sales in bulk at lower cost to large scale users must be initiated.

The Status of Some Composting Processes in U.S. Today

I. Frazer-Eweson Process at Bayshore, L. I.

This process was described in detail in last year's progress report of this committee.[1] At the time much hope was held out for the success of this composting process. Optimistic hopes were held out for a production of 10 tons per day of marketable fertilizer. The process was the most completely mechanized of any composting process in the U. S. to date. Considerable engineering ingenuity and judgment had been expended to make it operate efficiently.

This year it must be reported that the operations of Bayshore have not been a success. Instead of a production of 10 tons per day, production has averaged only 3 to 3-1/2 tons per week.[15] The trouble at Bayshore has been due to several factors: (a) The success of the project was predicted on separate collections. Instead of receiving garbage separated from other refuse, the plant has had to do its own segregating, thus increasing costs. Also the amount of organic refuse obtained from refuse collections has not been sufficient to maintain operations. Additional raw material in the form of duck farm wastes, sawdust and sludge have had to be purchased. (b) Mechanical difficulties

have developed. Conveyors purchased originally have not functioned properly. (c) A feature of the Frazer-Eweson Process is the silo-like digestor with zones of decomposition.[1] Difficulty has been reported[15] in dropping organic refuse from zone to zone down through the digestor.

The claims for the Frazer-Eweson process attracted the attention of Hagerstown, Md. officials who became interested in composting because the Maryland State Department of Agriculture had ordered Hagerstown to stop feeding uncooked garbage to hogs by July 1, 1953.

Hagerstown, Md. officials signed a contract with the Frazer interests for the construction of a composting plant like the one at Bayshore, L. I. In April of this year they decided to get out of the contract after hearing about the Bayshore plants' difficulties.[15] Right now they are contemplating purchasing a special grinder and they may begin open air composting operations.

Despite the difficulties outlined above in relation to the Frazer-Eweson composting process, it still remains the fastest aerobic composting process discovered so far (decomposition completed in 7 days) and the production "bugs" may be ironed out to make it a successful method.

II. Compost Corp. of America Operation at Oakland, California

This operation was considerably ballyhooed last year. Oakland was to be known as the city of "golden garbage".[1]

Indications are that Oakland has been a failure[3] because garbage after processing was actually "golden" in comparison with cost of chemical fertilizer. Dr. Pfeifer, whose special cultures for seeding were used at Oakland, figures it cost $35 per ton to produce compost ready for commercial sale at the city.[9]

The operations of the Compost Corp. of America were suspended last year pending a re-design of buildings and machinery.[16] New work expected to cost $180,000 and be able to handle 225 tons of garbage and produce 100 tons of salable compost per day is to be completed this year.

This composting operation should be watched since it represents the first large scale, commercial, open-air composting in the U. S.

III. Altoona FAM, Inc. Operation at Altoona, Pa.

For some time the Altoona FAM Co., formed by private investors, has been in operation at Altoona, Pa. producing compost from garbage and liquid digested sludge. Because the original process was neither economical nor practical, the FAM Co. has been in the process of complete reorganization.

The following information on the process has been supplied by Mr. Frank Varner, Superintendent, East Sewage Plant, Altoona, Pa.:

The city of Altoona has leased to the Altoona FAM, Inc. an abandoned incinerator building, adjacent to the site of the new Eastern Sewage Treatment Plant for a period of years in consideration of: (a) A very nominal sum of money, (b) that Altoona FAM would accept a minimum of 3 Packmaster loads of garbage per day, (c) that Altoona FAM would accept all of the liquid digested sludge from the treatment plant. These materials will be delivered to the plant site by the city. City of Altoona has separate collections and garbage must be wrapped in paper.

The FAM (Fluid-Agro-Mulch) process in step (a) takes the raw garbage material at plant site, and grinds it in a fresh water hydraulic media to a homogenized, aerobic and product of approximately 95% moisture content. Step (b) under the original process called for this resultant material to be

dewatered by laying it out in strips, plus or minus 4" thick, on the ground so as to leach out the free water to approximately 60% total moisture content. In step (c) of the original process, this caked material at 60% moisture was picked up, piled in heaps about 6 feet (6') high, covered with a light paper cap and left to compost down for about six weeks. In step (d) the resultant product of the compost cycle was screened, bagged and sold as a safe and beneficial soil conditioner.

In re-organizing operations it is considered that step (a) is quite successful. Steps (b) and (c) of the original process have been changed because step (c) required too long a time to produce the finished compost and step (b) required excessive hand labor as well as truck and tractor time. In step (b), it has been proved that economical use of mechanical dewatering equipment will remove 35% of the free water content between the grinding machine and the field compost beds for a continuous operation. Step (c) has been speeded up, with a better organic end product as a result, by innoculation of bacterial cultures into the freshly heaped material and the introduction of air, by mechanical turning, to maintain aerobic conditions. The composting material is kept odor-free during the breakdown cycle. It is claimed that the end product is an excellent soil conditioner.

IV. Composting Operations of Growth, Inc., N. Y., N. Y.

A pilot plant incorporating some of the features of the Earp-Thomas continuous-flow digestors, has been operating at Staten Island, N. Y. successfully composting organic raw material into marketable fertilizer in less than 36 hours.

The success of the pilot plant has launched Growth, Inc., a non-profit organization, which intends to enter into contract with municipal officials to build municipal composting plants, using bond issues to gain the initial capital. All profits are to go to aid education, with 75% earmarked for local areas supplying the organic raw material and 25% used to further research in its composting operations. To operate on a non-profit basis, Growth, Inc., through its president, Bernard Haldane, has established "The Public Trust for Education," a foundation expected to be chartered by the government.

Description of Process:

The pilot plant at Staten Island, N. Y. has a grinder which grinds the raw material. The ground material is then conveyed to the top of a 6 cell digestor of the Earp-Thomas type. Dependence on proper innoculation of the raw material with strains of bacteria is claimed. Up to now the bacteria have been obtained from the Earp-Thomas Laboratories at Hampton, N. J.

The vertical digestor is an all welded affair with a center revolving shaft on to which are attached arms or plows for moving and mixing the material. The mixing aids aeration which can also be controlled by injecting air and venting the cells. Gravity flow moves the material from one cell to another and the action of the plows is to move the material inward or outward in alternate cells. It is claimed that as the material is moved bacterial incubation goes on at increasingly higher temperatures to produce the finished compost in the bottom cell in 24-36 hours. A trap door in the bottom cell permits removal of the loamy end product.

The following estimates were made by Growth, Inc. for Kansas City to induce that city to consider composting of its municipal refuse:

ESTIMATED COSTS FOR KANSAS CITY
GARBAGE RECLAMATION, PROPOSAL
(population estimated at 500,000 plus)

Garbage available for reclamation (not including material fed to hogs) . . 150 tons daily		
*Cost of plant and housing . . . . (12 year depreciation)	$200,000	
**GENERAL OPERATIONS:		
Income from 18,000 tons NewLand at $20 . . .	$360,000	
Income from services	19,800	$ 379,000
Cost of Product, Sales, Administrative and General Expense. . . .		206,470
**INCOME FOR DISTRIBUTION: Gross income for education aid .		173,330
less 25%.		43,330
Net income for distribution in Kansas City as scholarships and grants to educational institutions		130,000

***EXPLANATION**

Cost of plant - 7 units, capacity 22 tons each daily (1 ton of contents - 1.2 tons as collected, auxiliary equipment and housing.

7 incubator or digester units and end product screening . .	$ 71,000
Grinders	16,000
Conveyors, storage and loading units	21,000
Testing and innoculation equipment	4,000
Structural steel, concrete work, etc. for housing	40,000
Local erection labor	18,000
Engineering fees and field supervision	30,000
TOTAL . . .	$200,000

****GENERAL OPERATIONS**

a. Income

1. Current operations estimated as 110 tons daily, 360 days, totals 39,600 tons annual. Disposal of this is charged to Kansas City at $0.50/ton, $19,800 (services income).

2. More than 20,000 tons of NewLand should be reclaimed. Allowing 10% for margin of error, the production figure comes down to 18,000 tons. A wholesale price of $20/ton is used, the retail price for similar products ranging up to $60/ton.

b. Cost of Product, etc.

1. Operating costs (2 shifts, 8 hours each in 12-hour day).

Labor	$ 30,000
Power (300,000 kw at 4 cents)	12,000
Maintenance, Insurance, Repairs, etc.	20,000
Bacteria (50 cents/ton treated)	19,800
Royalties ($1/ton NewLand)	18,000
Depreciation	16,570
TOTAL	$ 116,470

2. Sales, Administration, General (including interest at 5% on capital bonds) calculated at 25% of gross income from sales 90,000

TOTAL . . $ 206,470

***INCOME

The P.T.E. plan calls for distribution of net income in the following manner:

75% in areas providing the materials for reclamation;
25% to be distributed more broadly, not necessarily excluding the above areas, at the discretion of P.T.E. trustees.

PILOT PLANT COSTS: ESTIMATED ON 6-MONTH OPERATING BASIS, NO INCOME.*

Special incubator (12-15 ton capacity)	$10,000	
Grinder	2,000	
Conveyors, Storage, test units, etc.	4,000	
Housing and structural work	5,000	
Local labor	3,000	
Engineering and field supervision	7,500	$ 31,500
Operating costs (6 months)		
Labor (12 hrs. day)	5,000	
Power (60,000 kw)	2,400	
Other exp. and depreciation	3,000	$ 10,400
Special supervision, research, reports and general expenses		9,000
		$ 50,900.00

*Actual production should be at the rate of approximately 5 tons daily of NewLand

CONCLUSION

Growth, Inc. has figured that it costs Kansas City $1.60 per ton to grind and dump in the river approximately 138 tons of garbage daily. The dumping of the ground garbage has caused a pollution problem.

The proposal made by Growth, Inc. to Kansas City would reduce garbage disposal costs to no more than fifty cents ($.50) per ton from the current $1.60 (a net saving in excess of $45,000.00 annually). At the same time, it would end river pollution by garbage, and point the way to eventual termination of sewage pollution of the river. Financial returns (over $125,000.00 yearly) resulting from the sales of New-Land (the organic soil conditioner produced by compostnig municipal refuse) would be passed on to the citizens through the Public Trust for Education.

Pilot plants demonstrating this process are being operated successfully at Michigan State College, East Lansing and by Growth Incorporated on Staten Island, N. Y. These have pointed the way to numerous plant design improvements and cost reductions.

SUMMARY

From an economic viewpoint the composting of municipal refuse has not yet been put on a commercial basis in the U.S. A considerable number of composting operations have started up but they are more in the nature of pilot plants for probably larger operations to come.

Many municipal officials, like those of Milwaukee,[9] feel that the possibilities of composting are bright but are afraid to enter into large-scale composting operations because insufficient experience records have been built up of existing installations.

To develop composting of municipal refuse commercially, the risk capital of private investors must be combined with a co-operative attitude on the part of the municipal officials and the public. Large scale composting operations need the organic part of municipal refuse to operate but the cost of this raw material must not be set too high.

The comparative cost of other methods of refuse disposal and the aesthetic acceptability of these methods will remain the determining factors for considering composting as a method of disposal of municipal refuse. While composting cannot compete with hog feeding, dumps and landfilling on the basis of costs, composting operations will probably be more acceptable to the community because of the small danger of fly nuisance, odors or air pollution.

Composting should be considered along with incineration and other methods in any thorough engineering analysis of a municipal or industrial waste disposal problem. It will always cost something for a community to collect and dispose of its refuse and composting, while not showing a profit from a waste recovery standpoint, can still be justified as an economical waste disposal method in many cases.

GRINDING

The idea of grinding garbage for disposal with sewage is over 30 years old. In 1923, Fox and Davis introduced ground garbage into sewers leading to the sewage treatment plant of Lebanon, Pa. Keefer & Kranz by laboratory and field studies demonstrated that garbage could be ground, carried by city sewers and handled in the Baltimore, Md. sewage plant. In Durham, N. C., garbage was ground and discharged to the sewer system during peak waste periods associated with the watermelon season. At Indianapolis, Ind., a garbage grinding station discharged wastes into the sewage. At Schnectady, N. Y. garbage was discharged into the sewers in the early thirties.[51-3]

There are three methods of dual disposal of garbage with sewage; (a) by installing household garbage grinders and discharging the ground material, mixed with water, into the sewer; (b) by installing central municipally operated stations for grinding garbage to which it is hauled and then ground and dumped into the sewer; and (c) by hauling garbage to the sewage treatment works, where it is ground and discharged either into the raw sewage or into the digestion tanks.

Household Grinders:

The installation of household grinders progressed slowly from their inception around 1921, and until the beginning of World War II only some 55,000 installations had been made. Since the end of that war, a number of manufacturers have offered household grinders, so that their use has become more general. Marketing records of the National Electrical Manufacturers' Association indicate that the total number of grinders installed in the United States was over 1,000,000 in 1951.[53-7]

Universal adoption of grinders would be necessary if methods of collection and disposal of refuse are to be materially affected. In many cases, garbage constitutes only about 10 per cent of the total volume of refuse collected. As a very large proportion of the municipal refuse cost is in collection, the removal of less than 10 per cent of the material to be collected will result in but little saving in collection costs. The cost of household grinders will probably keep many communities from being wholly equipped with them.

Although many large cities encourage the installation of household grinders, a number of them still prohibit their use. Some limit their disapproval to installations in hotels, restaurants, etc. In some cases disapproval is due to apprehension that the existing sewage treatment plant will be overloaded. In others, the fear, entertained also by some states, is that there may be damage to the stream control program. In Indiana, cities operating sewage treatment works on a revenue bond basis are authorized to issue revenue bonds to finance the installation of kitchen garbage grinders, if adequate sewage treatment facilities exist.

Installations:
Jasper, Ind.

Jasper (population 5,215) attracted nation-wide attention in 1949 by its decision to dispose of all decayable food wastes from homes by kitchen garbage grinders. This decision made it the first community in the United States, and probably the world, to attempt City-wide installation of household garbage grinders. At present over 900 grinders are in use, serving 75% of the community's population. As a result of this decision, plans for a sewage treatment plant for a design population of 10,500 (1975) were revised as follows:

	Without Gargage	Garbage and Sewage
Design Flow	**1.0 M.G.D.**	**1.0 M.G.D.**
Comminuter	**One 15"**	**One 15"**
Primary settling	**2 units-1.55 hr. detention**	**2 units-1.55 hr. detention**
Aeration Tanks	**2 units-5.2 hr. detention**	**3 units-7.8 hr. detention**
Final settling	**2 units-2.6 hr. detention**	**2 units-2.6 hr. detention**
Sludge Digesters	**1 unit-4.2 cu. ft./cap.**	**2 units-6.6 cu. ft./cap.**
Sludge beds	**4 units-1.9 sq. ft./cap.**	**8 beds-3.1 sq. ft./cap.**

A joint study of the "Jasper Plan" covering the period from March 1950 to October 1951 was made by the Indiana State Board of Health and the U. S. Public Health Service.(53-5) A summary of the findings is as follows:

1. **No noticeable increase in water use**
2. **No deleterious effect on the sewers (sizes 6" to 12"; velocities 1.75 to 6.8 ft.per sec.)**
3. **Organic load (B.O.D.) increased from 0.12 to 0.18 lb. per capita per day**
4. **Organic load attributable to ground garbage has varied considerably in terms of sewage load**
5. **Grease observed was 0.07 pound per capita per day**
6. **Peak B.O.D. loadings from garbage were in the neighborhood of 250 per cent of the average**
7. **The concentration of volatile solids in the grit was around 80% and the moisture content about 76 %.**
8. **Average concentration (B.O.D. of raw sewage ranged from 228 p.p.m. with 8% grinders to 410 p.p.m. with 72% grinders.**
9. **Suspended solids removal by primary tanks averaged about 70%..**
10. **When no waste-activated sludge was present, raw sludge concentration averaged 5.8% with volatile solids content of 72%; with such sludge, the concentration dropped to 3.5% with but little change in the volatile content.**
11. **Results of secondary treatment were erratic because of the usual operational difficulties when breaking in a new sewage treatment plant.**
12. **Indications were that the number of flies were reduced, due to the improved garbage-handling practices.**
13. **The rodent population also appeared to be reduced.**

Los Angeles, Calif.

About one family in eight in Los Angeles (population 2,000,000) has kitchen food-waste disposers in operation, a total of roughly 80,000 grinders. The increasing use of grinders has resulted in a steadily reducing quantity of garbage collected by city forces, which dropped from 0.65 pound per capita per day in 1946-47 to 0.48 in 1951-52.(53-2)

Until very recently there had been no evidence of the ground garbage in the sewer system. However, the need for maintenance increased in the upper

terminus of a sewer built on a relatively flat grade and serving a number of apartment houses, as heavier particles settled out and clung to the side of the sewer, causing odors. Also, a heavier blanket of scum was observed in the wet wells of the pumping plants, caused by garbage floating on the sewage. The ground food wastes have not presented any problems in the sewage treatment plant.[53-2]

There were 31,000 new disposers installed in 1952 and 45,000 are expected to go in during 1953. The City looks with favor on this increased use of grinders because of their reduction of fly and rodent hazards, odor nuisances, etc. and because of the useful by-products obtained from the treatment of the food wastes with the sewage at the sewage plant.[53-2]

Cleveland, Ohio.

Between 15,000 and 20,000 grinders are in operation in Cleveland (population 915,000), or one for every 15 households. About 2,000 are being installed each year. No substantial change in the character of the refuse collected could be attributed to the grinders. No sewer line has given any trouble because of the grinders; nor has any appreciable difficulty been experienced at the sewage treatment plant. The City strongly favors the adoption of grinders as a step toward cleaner household conditions, less garbage to be collected by the City forces, and less of a load on the municipal incinerator.[53-2]

Oklahoma City, Okla.

There are about 4,000 grinders in use in Oklahoma City (population 244,000), or one per 15 families. They are being installed at the rate of 300 per year. The City ordinance provides for the installation of domestic grinders only, in single-family houses. No difference has been observed in the amount of garbage collected (which is fed to hogs), in the functioning of the sewer lines, nor in the operation of the sewage treatment plant.[53-2]

Detroit, Michigan.

In Detroit (population 1,850,000) there are about 20,000 domestic grinders, or one for every 23 families. More are being installed at the rate of about 2,500 per year. There has been no measureable decrease in the quantity of refuse collected (garbage and rubbish are collected together). No trouble has been experienced with the sewer lines because of the grinders. The City favors the increased use of the food-waste disposers, to reduce or eliminate City garbage collection and incineration, even though it will increase the need for more sludge disposal and chlorination facilities at the sewage treatment plant.[53-2]

Indianapolis, Ind.

With a population of 427,000, Indianapolis has about 4,500 kitchen garbage grinders, or one per 24 families. Installations are going in at the rate of 500 to 1,000 per year. No trouble has been experienced in the sewer system, nor has the volume of sludge increased at the sewage treatment plant because of these grinders.[53-2]

Minneapolis, Minn.

Minneapolis (population 522,000) has approximately 5,000 kitchen grinders in service (roughly 1 for every 26 families) and about 1,000 more units are

being installed yearly. While the volume of refuse collected has remained about the same, its weight has dropped from 230 to 225 tons daily. No difficulty has been experienced with the sewerage system.(53-2)

Washington, D. C.

Washington (population 800,000) has about 6,000 grinders, - one for each 30 families. About 1,000 units are being installed annually. The City also operates a 10-ton garbage grinder, from which ground garbage is sent to the treatment plant.(53-2)

Philadelphia, Penn.

Upon the completion of its Northeast sewage treatment works in 1951, Philadelphia (population 2,000,000) lifted its ban on kitchen garbage grinders in the area served by the plant. Prior thereto the dumping of deleterious matters into the sewers was prohibited by an 85-year old ordinance.(51-17)

Shorewood Hills, Wis.

The Village of Shorewood Hills, Wis., is essentially a small residential community of about 475 homes occupied by approximately 1,700 people. When public health officials refused to permit the dumping of garbage or the feeding of same to hogs on lands under their jurisdiction, the village was forced to haul its garbage to a farm 35 miles away. Both sanitary landfill and incineration being prohibitive in cost, garbage grinding was thoroughly investigated as to experience elsewhere, effect on sewers, sanitary benefits, reliability, cost and method of financing. As a result the village awarded a contract for the installation of domestic garbage grinders in all homes. Six local contractors bid on the project, the low bid being \$60,897.50.(53-3; 53-8)

Effect on Sewers and Sewage Treatment Plant

Experience at Jasper, Indiana, indicates that a municipality can satisfactorily dispose of garbage with home grinders provided: (1) its sewers conform with the accepted standards for sanitary sewers; (2) its sewage treatment facilities are adequate or provisions for expansion are provided; and (3) its population is progressive and financially able to support any type of garbage disposal facilities.(50-1)

When and if half the dwellings of a community are equipped with disposers, the sludge load at the sewage plant will not be increased by as much as 20 per cent. It will more likely be in the neighborhood of 10 per cent.(49-1)

If garbage is discharged into combined sewers, there may be some overflow of this material during storms at the controls to the interceptor. Since this will occur only during storms, when dilution is high, the additional pollution of the water course may be appreciable only in exceptional cases.(47-1)

According to tests by the U. S. Public Health Service, food wastes apparently do not affect operation of the septic tanks of private sewage disposal systems or the character of the effluent therefrom. However, a 25 to 50% increase in tank capacity is indicated.(51-3)

On the basis of 3 months' experimental research with household garbage grinders at Detroit, Michigan, the following conclusions were reached as to the effects of the introduction of ground garbage into a sewer system: (1) On the average, 25 per cent of the dry solids will go into solution or non-settleable suspension in the grinding process. (2) Limitations on acceptable garbage

grinder operation should specify that not more than 30 per cent, on the dry basis shall pass a No. 40 U. S. Standard sieve. If it is assumed that 100 per cent of a community's garbage is ground and introduced into the sewer system for disposal at the sewage treatment plant, the following conclusions could also be reached: (3) The chlorine demand of the effluent of the primary sedimentation process may be increased 0.12 p.p.m., or about 4 per cent, as a maximum. (4) The average increase in B.O.D. of primary effluent would be from 20 to 25 per cent. (5) The increase in solids to be handled at a primary plant, would average about 50 per cent.[51-5]

Costs

In appraising the economics of the kitchen garbage disposer, one should not limit the considerations to the probable effects on sewage treatment, but should broaden the scope to include the interests of the municipal housekeeper as well as the individual householder.[49-1]

At Jasper, Ind., (population 5,200) comparative costs showed that the home grinder method of garbage disposal was only slightly more expensive per family per month than disposal by central grinding or sanitary landfill. The estimated costs were as follows:[50-1]

Disposal Method	Original Investment	Cost, incl. Amortization, Labor, Depreciation, Maintenance and Operation: Total Annual	Monthly Cost per Family
Home Grinders	$122,500*	$11,805	$0.66
Central Grinding	43,000	11,742	0.65
Sanitary Fill	27,000	10,930	0.61

*$40,000 for treatment plant increase, plus $82,500 for grinders installed.

An ordinance was adopted in 1950, requiring each Jasper home owner to provide his own garbage disposal facilities if he did not install a garbage grinder. The City acted as agent for the home owners so that wholesale rates were obtained for the purchase and installation of the grinders, the contract unit cost being $75.00. Local banks arranged for time payments where necessary.[50-1]

Jasper specifications provided for the cutting of sinks to adapt the garbage grinders and the reaming of the waste line between the sink and the main house sewer. Six concerns bid, some on a "completely installed" and some on a "furnish only" basis. The contract was awarded on the former basis. Two types of tests were conducted for each grinder submitted: a dry run and a composite sample. The dry run test showed the desirability of a water interlock to immediately flush the grindings away. This is a flow-type switch inserted in the cold-water line and wired in series with the sink switch so that a given volume of water must be flowing in the cold-water line before the unit will operate. The composite sample included a large variety of food waste that might normally be put through a food waste disposer, plus some items that might drop into a sink accidentally, such as metal bottle caps. The latter items were included to determine whether they would jam a machine and make dismantling necessary.[50-1]

Trend

While the trend is toward an increasing number of home garbage grinder installations, a recent study in the East Bay area at San Francisco, Calif., indicates that only 30% will be installed by 1970 and 70% by the year 2000. If this is true, the effect of food wastes from this source will generally be of minor importance at sewage works for the next 25 years. Since the trend is as indicated above, however, designing engineers should recognize it and where necessary, design their plants accordingly.[47-1]

If the use of garbage disposers follows the sales pattern of most other household appliances, it will be more than 20 years before half the dwellings in the average community will be so equipped.[47-1]

A dozen or more manufacturers and distributing companies are marketing household garbage grinders. Over 500,000 units are in use in 350 or more communities in the United States. Many units are operating on septic tanks of private sewage disposal systems. A trend toward the use of commercial units in communities is indicated by the recent Dearborn, Mich. ordinance requiring their use in all new buildings, except 1 to 4-family residences, and in all buildings remodelled and used for storing and preparing various types of foodstuffs for human consumption.[51-3]

Central Grinding Stations

Grinding stations can be of very simple design, with manual feed, where small tonnages are ground, or quite elaborate, with mechanical feed, where large tonnages are expected. They can be located at the sewage treatment plant or at strategic points on the sewer system. If located at the plant, the ground garbage can be added to the raw sewage entering the plant or it can be added directly to the digesters. Properly designed, such stations should go far toward satisfactorily handling the garbage grinding and grit removal operations, while provision of adequate digester capacity should solve that phase of the problem.[47-1]

Garbage grinding stations need not be objectionable. Exterior architecture should harmonize with the neighborhood, grounds should be landscaped to present a pleasing appearance, and doors and windows should be tight. Garbage should be dumped and ground only when doors and windows are closed. Fans should constantly exhaust the inside of the building and the air should be put through activated carbon containers, ozone, or other mans of purifying the air, as is done at some sewage treatment plants. Another possibility of odor control would be to pass the exhaust air through a furnace where temperatures of 1,200°F are maintained, before sending it to the stack. These features cost money, but it is believed that the overall economic savings will outweigh the added costs.[47-1]

Any City contemplating dual disposal should require that green garbage only be sent to the garbage grinding station. This will avoid the costly sorting and disposal of the non-grindable material. Such wastes must be disposed of in the same manner as are ashes, trash and other rubbish.[47-1]

Installations

Findlay, Ohio

The sewage plant at Findlay, Ohio is designed for a population of 35,000. In 1938, secondary treatment by activated sludge was added to the original sedimentation tanks with separate sludge digestion and sand drying beds. At

the same time a garbage grinder was installed but the capacity of the sludge treatment facilities was left unchanged. Garbage, sprinkled with lime for odor and pH control, is ground usually once on the day shift and once on the night shift, each operation taking 15 to 30 minutes. It is introduced into the sewage ahead of the detritor.(47-1)

Marion, Indiana

At Marion, Indiana, (40,000 people) garbage was added directly to the raw sewage entering the activated sludge plant from June 1941 to May 1943. Then a garbage pit with an effective capacity of about 4,000 gallons was formed by partitioning off a portion of the wet well in the sewage pumping station.(47-2) It can store about 4 tons of green garbage with a 5% solids content. Lime was added to the pit for pH control except when the garbage was promptly pumped to the digester. Operating records show the gallons of waste sludge per 100 p.p.m. of suspended solids to be about the same whether garbage solids are discharged to the primary tanks or directly to the digesters. The quantity of garbage was 0.8 ton per million gallons of sewage.(47-1)

Goshen, New York

At Goshen, N. Y., garbage is ground at the sewage plant and sent directly to the primary sludge digestion tank. The plant was put into operation in 1940 and consists of primary settling tanks, two heated digesters, drying beds, and a sand filter for secondary treatment in the summer months. For the population of 3,000 and average flow of sewage of 450,000 gallons per day, the digester capacity was 4.3 cu.ft. per capita and the garbage averaged 0.51 lb. per capita per day, or 1.6 tons per m.g. of sewage. Ground garbage excluding so-called garbage grit (bottle tops, glass, bones, etc.) is blown by an ejector directly to the primary digester. Between the primary and secondary digesters is a manhole at which, when necessary, larger inorganic solids can be removed before the sludge is ejected to the secondary digester.(47-1)

Lansing, Mich.

At Lansing, Mich. all garbage is ground at the sewage plant and, after removal of grit in aerated holding pits, is sent to the heated digesters of the sewage plant, which is of the standard activated sludge type, designed for a population of 80,000 in 1938. The digested sludge is dewatered on vacuum filters and then incinerated. Additions to the plant in 1950 because of serious overloading raised its capacity from 9.0 m.g.d. to 20 m.g.d. from a population of 125,000. Digester capacity was increased from 3.7 to 11.0 cu.ft. per capita. Green garbage amounted to 0.66 lb. per capita per day, having solids amounting to 17.5% with a volatile content (on a dry basis) of 88.4%. It is dumped on the floor and fed manually to a grinder after the heavier non-organic matter is picked out. The ground pulp is blown directly to the digesters.(47-1)

Richmond, Indiana

Richmond, Ind. has been grinding its garbage and pumping it into the digesters of its sewage treatment plant since the Spring of 1951. This plan was adopted in connection with an enlargement of the sewage treatment plant because: (1) separate collection of garbage was an established practice; (2) sites for landfill disposal were difficult to find and expensive; (3) equipment for grinding sewage screenings was in use; and (4) the additional gas would be

useful for operating the activated sludge plant. Digester capacity of 10 cu.ft. per capita was provided for combined sewage sludge and garbage.(53-1)

Effect on Sewers

As to the effect of ground garbage on the sewer system, there need be no fear of stoppage occuring from this material. Combined sewers are designed for minimum velocities of approximately 3 feet per second, and since the grinding stations would be located only on the larger sewers, the velocities and the volume of flow would be sufficient to prevent stranding of solids. Local conditions should always be studied, but with a proper site chosen to insure a grinder selected to allow only garbage solids of a certain maximum size to be discharged into the sewer, and control of the feeder to keep out heavy nonorganic matter, there can be reasonable certainty that no sewer stoppages will result. Garbage grit, amounting to approximately 40 lb. per ton of garbage, must be waterborne to the treatment plant (unless it is removed by special apparatus), but since the size of particles will be smaller and their specific gravity lower than the largest and heaviest particles of sand and gravel now carried by sewers, there should be no undue alarm because of the addition of a smaller amount of lighter and more easily transportable garbage grit. Garbage grit will probably not exceed 1.0 cu.ft. per m.g. where garbage is added to the sewage at a rate of 1.0 ton per m.g.(47-1)

Effect on Sewage Treatment

It appears on first thought that garbage would add a very heavy load to that which the sewage plant must treat, but every sewage plant always receives a considerable amount of waste from domestic preparation of food. Besides juices, any solids fine enough to pass the sink strainer are flushed into the sewer. In any case, the additional load (from household grinders) need cause the sewage plant operator no alarm. Any calculations of solid loadings, either garbage or sewage, or both, should be made on a comparable basis of either total solids or suspended solids.(49-1)

The increase in strength of raw sewage from garbage is dependent upon the pounds added and the nature of the garbage solids. The average annual quantity of garbage is normally 0.5 pound per capita per day. The quantity varies, of course, with the season and may be only one-half of this figure during the winter months and twice this average during the late summer and early fall.(47-1) The total solids in green garbage varies from 15 to 30% and are partly in suspension and partly in solution, the suspended solids including some grit which the sewage plant grit chamber could remove. The greater the distance from the plant that garbage is ground, the less will be the suspended solids arriving at the plant, due to leaching out of soluble garbage solids by the flowing sewage. Tolman(47-1) estimates that garbage having total solids of 17.5%, suspended solids of 260 lbs. per ton, and B.O.D. of 152 lbs. per ton, when added at the rate of 1 ton per million gallons to raw sewage having 250 p.p.m. of suspended solids and 200 p.p.m. of B.O.D., will increase the suspended solids by 12.5% and the B.O.D. by 9.0%.

Primary Settling

At Indianapolis, during a six months test in 1935, 2.0 tons of ground garbage per m.g. was added to the raw sewage. The mixture contained 382 p.p.m. of suspended solids and 273 p.p.m. of B.O.D. The suspended solids in the raw

sewage increased 13% and the B.O.D. 15% ; in the settled sewage, the corresponding figures were 3% and 11% . These data indicate that garbage solids and B.O.D. are removed more rapidly by primary settling than are sewage constituents.(47-1)

A study of the performance at the Findlay plant (where garbage is added ahead of the detritor) is interesting because a good comparison can be made with and without garbage. The digester was overloaded, no doubt due partly to the addition of the activated sludge facilities to the plant. However, addition of the garbage did not produce unfavorable results in the primary tanks, although affected at times by a deficiency in sludge treatment capacities. The comparison before and after garbage was added is as follows:(47-1)

	Before (6 years)	After (7 years)	Increase Per Cent
Flow, m.g.d.	1.8	2.2	22.2
Quantity of garbage, tons per m.g.	0.0	1.1	----
Quantity of grit, cu.ft. per m.g.	1.5	2.7	80.0
Primary Settling, hours	4.3	3.5	----
Suspended solids, raw, p.p.m.	172	208	15.1
Suspended solids removal, %	53.0	54.8	----
B.O.D., raw, p.p.m.	167	202	21.0
B.O.D. removal, %	25.4	27.2	7.1

At Marion, Ind., ground garbage has been added directly to the sewage part of the time and part time directly to the digesters. The plant is of the activated sludge type designed to serve a population of 40,000, but is operating at about 75% of capacity. At times it is subject to severe loads from canneries and packing houses. Operating experience indicate that garbage suspended solids and B.O.D. are removed at least as readily as similar constituents in raw sewage.(47-1)

The results of primary settling at Findlay, Ohio and Marion, Ind., indicate that garbage solids and B.O.D. are removed as readily as are similar sewage constituents: that garbage B.O.D. does not retard the oxidizing ability of activated sludge; that garbage solids are as readily digested as are sewage solids; that gas production is increased in direct proportion to the amount of volatile solids added; and that the resulting sludge will be of somewhat lower solids content.(47-1)

Secondary Treatment

Little or no effect of ground garbage upon activated sludge plant operation at the Indianapolis, Findlay and Marion plants is evident, the plant efficiency so far as air goes (B.O.D. removal in lb. per 1,000 cu.ft. of air) being practically the same whether garbage is present or not. From this it is concluded that garbage solids are oxidized by activated sludge as readily as are sewage solids.(47-1)

Sludge Digestion

If garbage is added directly to the digesters, in general, facilities should be provided for first removing the garbage grit. This can be accomplished by several means: (1) by passing the garbage mixture through an ordinary grit channel with enough water so that its solids content will not be more than 4 or 5 per cent; (2) by providing a garbage pit equipped with air agitation, to which the garbage is added with enough water to bring its solids content down to

approximately 5 per cent, and, after agitation with air for a few moments, pumping the top liquor to the digester and the material in the bottom of the pit to the plant grit chamber; (3) by passing the mixture through a grit washer, with the overflow passing to a wet well from which the slurry is pumped to the digesters.(47-1)

At Findlay, Ohio, the digesters operated very well when handling only primary sludge. With the addition of secondary (excess activated) sludge and garbage, the solids in the digested sludge decreased more than 50 per cent, a supernatant of high solids developed, and the digester loading (lbs. of dry solids per cu.ft. per month) doubled. These results clearly showed a need for increased digestion capacity.(47-1)

At Marion, Ohio, digestion was satisfactory and gas production high when the digesters were handling primary and excess activated sludge solids without garbage. However, the supernatant was not satisfactory and the digestion capacity too low. When ground garbage was added to the sewage, either to the plant influent or directly to the digesters, digestion was less complete (especially when the garbage was added directly to the digesters), the quality of the supernatant was unsatisfactory, and gas production per million gallons of sewage was less due to larger sewage flows of lower strength.(47-1)

At Goshen, N. Y., digestion has been satisfactory, the supernatant being a light straw color having a B.O.D. of less than 300 p.p.m. and total solids of approximately 2,000 p.p.m. Ninety per cent of the gas produced comes from the primary digester, so that the second tank is relatively quiet for consolidation of the sludge and for decantation of the tank liquor.(47-1)

At Lansing, Mich., before the plant was enlarged, the high solid content in the supernatant, together with the high has production, indicated that the digester tanks were so agitated that the digested sludge did not have an opportunity to consolidate and leave a relatively clear supernatant zone. This was undoubtedly due to insufficient digester capacity.(47-1)

Costs

The principal advantage in grinding garbage at central stations is an economic one. Garbage added to the sewage at these stations is waterborne to the sewage plant and every mile saved by this method of transportation means that much saved in haulage cost. Other possible savings in collection costs may accrue from the re-routing of trucks to the grinding station and, in larger cities, the levelling out of the organic load at the sewage plant (especially with night collections).(47-1)

In comparing garbage disposal by grinding with other methods of disposal, interest and depreciation charges on the first cost of the increased size of the sewage disposal plant units to take care of the additional garbage load must be considered, as well as operating and maintenance expenses. Only thus can the method of disposal with the lowest annual capitalized cost be determined. Rough calculations of this kind have indicated that garbage digestion and disposal at the sewage treatment plant is probably the most economical.(47-1)

At Lansing, Mich., the City supplies and cleans the garbage cans for an annual charge of $1.50 per family. When a can is collected, a previously cleaned one is left in its place. At the sewage treatment plant, the empty cans are put through an automatic machine which thoroughly washes, sterilizes and dries them.(47-1)

The total average annual operating cost of garbage disposal at Findlay, Ohio, has been estimated to be $755.00 or 0.80 per ton of green garbage. The average quantity of garbage was 880 tons per year and the items included in

the cost were: pumping garbage solids to digesters; labor, electric power and miscellaneous supplies for operation of grinder; maintenance of grinder; disposal of cans, bones, etc, that could not be ground; and removal of digested garbage sludge. Allowing a credit for gas from the digestion of the garbage ($385.00), the net cost of disposal is reduced to $0.42 per ton of green garbage.(47-1)

At Marion, Ohio, the corresponding annual costs for disposal of 4.961 tons of garbage were: total expense, $3,370.00, or $0.68 per ton; net cost, after deducting credit for gas, $338.00, or $0.07 per ton.(47-1)

The construction cost of the Richmond, Ind. sewage treatment plant properly chargeable to the garbage disposal portion of the plant was $101,750.00.(53-1) The operating cost of garbage disposal in 1952 was as follows:

Operating grinder and conveyor, pumping to digesters, supervision and maintenance, and disposal of sludge on farms	$4,286.00
Credit for 8,080,000 cu.ft. of garbage gas utilized by 3 gas engines and for heating and digesters and buildings, at $0.65 per 1,000 cu.ft. (local gas company rate)	5,993.00
Profit (- $0.69 per ton of garbage	$1,707.00

Trend

Municipalities have given special consideration to the advantages of a central grinding station when: (a) garbage collection and disposal has become unduly difficult or expensive; (b) a new sewage treatment plant is to be constructed; or (c) the inadequacy of the existing sewage treatment plant makes additions thereto mandatory. When the garbage grinding station is located at the sewage treatment plant, the tendency is to pump the ground material directly to the sludge digestion tank.

SUMMARY AND CONCLUSIONS

There is very little difference in the physical, chemical and biological characteristics of sewage and ground garbage, especially so far as the ability of the sewer to carry and the treatment plant handle either or both. Three methods are in use for grinding garbage: (1) household or kitchen grinders; (2) central or municipal grinding stations discharging into sewers; and (3) grinders at sewage plants discharging directly to sludge digesters.

The first method is convenient to housewives and domestic establishments, eliminates garbage collection (including the garbage can), and generally has no clogging effect on the plumbing fixtures. Naturally, the garbage and water used for flushing increases somewhat the load on the sewer and sewage treatment plant, and the cost thereof. However, from the standpoint of increased service, sanitation, and convenience, this method is sound and is increasing in popularity.

At an increasing number of cities the garbage, after collection by the City, is ground at a municipal station, usually located at the treatment plant, and discharged into the raw sewage going to the plant. Quite frequently, the garbage ground at the sewage plant is discharged directly into the sludge digesters.

In a comprehensive discussion of the subject of ground garbage, Tolman(47-1)

ends with the following very valid conclusions and recommendations, where garbage is added to the sewage at an average daily rate of 2 tons per m.g. of sewage:

1. Facilities should be provided for removal of garbage grit before this material is sent to the digesters.
2. When garbage is added to the raw sewage, the increase in suspended solids will be approximately 25 to 35 per cent and in B.O.D. 18 to 26 per cent, depending upon the solids in the raw garbage.
3. The strength of primary settled sewage after 20 hours settling will be approximately 10 to 14 per cent in suspended solids and 11 to 16 per cent in B.O.D.
4. Garbage matter is oxidized by activated sludge and probably by all secondary processes as efficiently as is sewage material; therefore, increased plant secondary units must be based upon the increased garbage load in the primary effluent.
5. For digestion of primary solids and garbage, 5 cu.ft. per capita of digester capacity is needed.
6. The most economical means of dual disposal appears to be by direct addition of garbage to the digesters, unless central grinding stations are used.
7. The cost of disposal of garbage at the sewage plant will be between $ 0.10 and $0.50 per ton. (This excludes interest and depreciation on the first cost of the added plant, and includes a credit for excess garbage gas).

Respectfully submitted,

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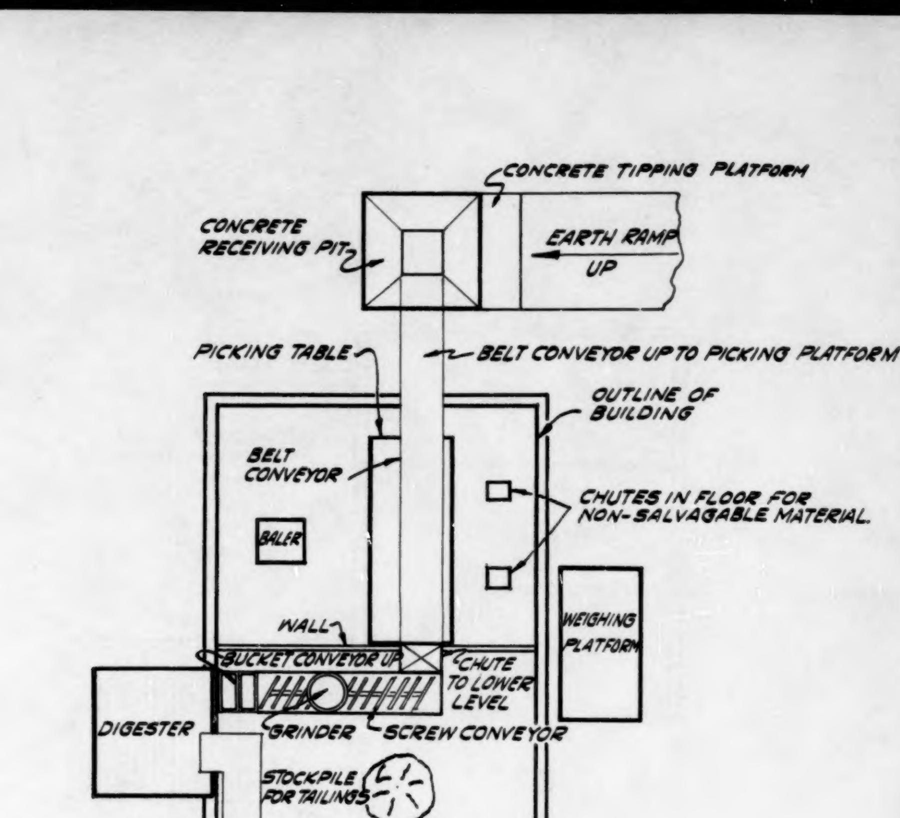
CONCRETE TIPPING PLATFORM
CONCRETE RECEIVING PIT
EARTH RAMP UP
PICKING TABLE
BELT CONVEYOR UP TO PICKING PLATFORM
OUTLINE OF BUILDING
BELT CONVEYOR
CHUTES IN FLOOR FOR NON-SALVAGABLE MATERIAL.
BALER
WEIGHING PLATFORM
WALL
BUCKET CONVEYOR UP
CHUTE TO LOWER LEVEL
DIGESTER
GRINDER
SCREW CONVEYOR
STOCKPILE FOR TAILINGS
ROCKER CONVEYOR WITH SLEEVES AND BURNERS.
CONVEYOR FOR TAILINGS
STOCKPILE FOR DRIED COMPOST.
CONVEYOR
BAGGING HOPPER
SEWING MACHINE
OFFICES
TOILETS

Fig. 1

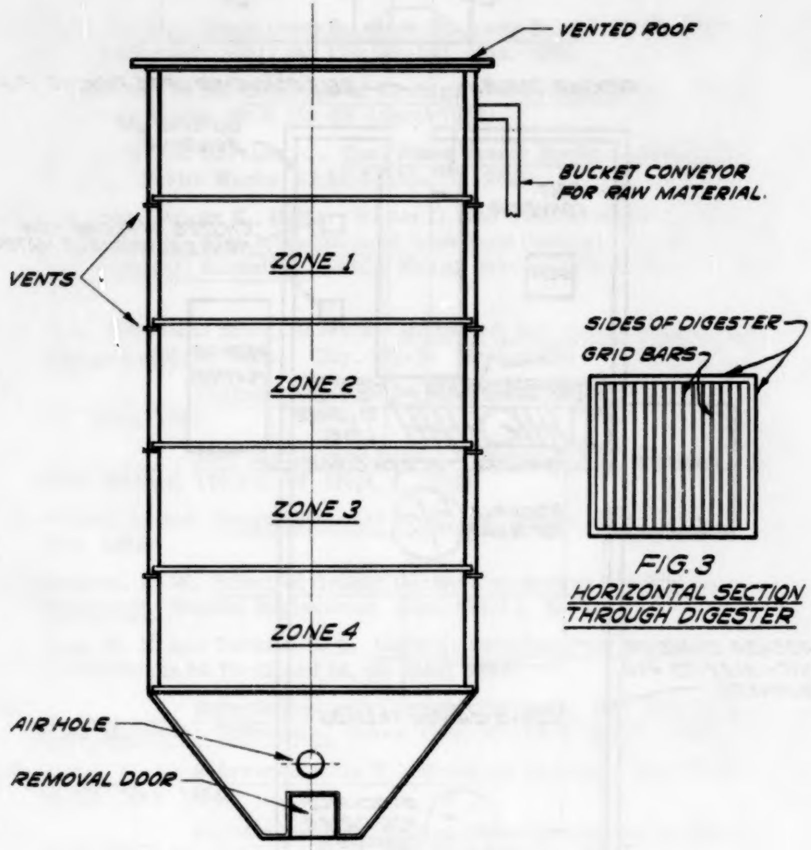

Fig. 2
Vertical Section Through Digester